A resurrection of *Copaxa canella flavobrunnea* Bouvier, 1930 and elevation to species status, with illustration of the early stages (Lepidoptera: Saturniidae)

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Abstract: *Copaxa canella flavobrunnea* Bouvier, 1930 is resurrected and elevated to species status, based upon adult external morphology, genitalia and nuptial flight time of the males, all of which distinguish it from its closest relatives, *Copaxa canella* Walker, 1855, and *Copaxa joinvillea* Schaus, 1921. Males vary markedly in color and are diurnal, unlike the latter two species, and search for females during late morning beginning about 9:00 h. Larvae were reared in the laboratory and fed on *Persea americana* (Lauraceae). Adults and early stages are illustrated in color.

Una resurrección de *Copaxa canella flavobrunnea* Bouvier, 1930 y su elevación a estado de especie, con ilustraciones de los estadios inmaduros (Lepidóptera: Saturníidae)

Resumen: Se resucita la *Copaxa canella flavobrunnea* Bouvier, 1930, y se eleva a estatus de especie, basándose en la morfología externa del adulto, en los genitales y por la hora de vuelo nupcial del macho, todos caracteres por los cuales se distingue de sus parientes más cercanos, la *Copaxa canella* Walker, 1855, y la *Copaxa joinvillea* Schaus, 1921. Los machos son muy variables de color y son diurnos al contrario a estas dos especies. Buscan las hembras en la mañana comenzando cerca de las 9:00 h. Se criaron las larvas en el laboratorio, donde se alimentaron de *Persea americana* (Lauraceae). Se ilustran en colores los adultos y los estadios inmaduros.

***Copaxa canella flavobrunnea* Bouvier, 1930 aus der Synonymie zur separaten Art erhoben, mit Abbildung der frühen Stadien (Lepidoptera: Saturniidae)**

Zusammenfassung: *Copaxa canella flavobrunnea* Bouvier, 1930, beschrieben als Unterart und später synonymisiert mit *Copaxa canella* Walker, 1855, wird als separate Art erkannt und auf Artniveau erhöht. Sowohl der Paarungsflug der farblich variablen Männchen am späten Morgen ab 9.00 h wie Genitalmorphologie und Habitus sind kennzeichnend für die neuerkannte Art und unterschieden sie von den beiden nächsten Verwandten, *C. canella* Walker, 1855 und *C. joinvillea* Schaus, 1921, mit nachtaktiven Männchen. Die Raupen wurden in Gefangenschaft mit *Persea americana* (Lauraceae) aufgezogen. Imagines und Jugendstadien werden in Farbe abgebildet.

Introduction

Copaxa canella flavobrunnea Bouvier, 1930, an eastern Brazilian taxon, was described as a subspecies by Bouvier (1930) and later synonymized with *Copaxa canella* Walker, 1855 by Lemaire (1975). However, its smaller size and more acute forewing apex in the ♂ have led scientists and enthusiasts alike to mistakenly identify it as *Copaxa joinvillea* Schaus, 1921. Possibly hundreds of specimens provided by commercial collectors and breeders in Brazil now found in world collections are labeled as *joinvillea*. Due to new findings, this taxon is recognized as distinct and is elevated to species level with the resurrected name of *C. flavobrunnea*.

Copaxa flavobrunnea Bouvier, 1930, new status

Copaxa canella flavo brunnea [sic, original misspelling, obligatory emendation to *flavobrunnea*] Bouvier (1930: 93); lectotype (by subsequent designation by Lemaire 1978: 182, cf. Lemaire 1978: 36, footnote 2) in BMNH, London [examined].

While in Brazil, in the southeastern state of Santa Catarina in 1999, I purchased several cocoons said to be of *"C. joinvillea"* which I placed in my tent while light-collecting for moths. By next morning a ♀ had eclosed, and shortly after 9:00 h numerous ♂♂ emerged from the forest attracted by her pheromones. One was allowed to couple with her in order to obtain viable eggs for study of the immature stages.

Subsequently, at the BMNH, London, I found several ♂ specimens of this taxon while examining a series of specimens of *Copaxa canella,* among which they contrasted, not only by their smaller size and shape (Fig. 9) but also by their darker antennae (not distinguishable in the illustration). My unpublished notes document that ♂♂ of New World Saturniidae with pale rami on the antennae are always nocturnal while searching for ♀♀ while those with dark rami are usually diurnal. ♂♂ of the present taxon have dark antennal rami, while ♂♂ of both *C. canella* and *C. joinvillea* have pale rami, and are thus nocturnal rather than diurnal.

Dissection of the ♂ genitalia (Fig. 10) ruled out *C. joinvillea*, for lack of a tooth on the anterior margin of the juxta (Fig. 12; see also Lemaire 1978). Compared to *C. canella*, ♂ genitalia differed by the more widely separated apical processes of the uncus, the longer and narrower gnathos and slight differences in the aedeagus (compare Figs. 10–12).

Based on adult size, wing shape, color, genitalia and time of ♂ nuptial flight, there is enough indication that this taxon is specifically distinct from *C. canella*, and Bouvier's name, *C. flavobrunnea*, takes precedence for this taxon.

External morphology of *C. flavobrunnea* differs from both *C. canella* and *C. joinvillea* by its greater diversity of color among mature ♂♂ (Fig. 1). All specimens of *C. canella* examined were fawn colored in both ♂♂ and ♀♀, with some reddish or yellow tint in the forewing cell and pale antennae. The ♂ of *C. flavobrunnea* averages smaller than *canella*, has more falcate forewings, and colors that range through brown, black, yellow, and orange with variable combinations and patterns. ♀♀ of *C. flavobrunnea* do not display yellow or reddish in the forewing cell. Although the ♂ of *C. flavobrunnea* is similar in size to *C. joinvillea* the forewing apex is less acute, and there is less pinkish gray outside the postmedial line of the forewing. Antennae with dark brown rami. In all specimens of *C. joinvillea* examined, ♂♂ were rather uniformly patterned and colored, the wing veins, especially on the forewings, were out-

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Figs. 1–8: *Copaxa flavobrunnea*. **Fig. 1:** Reared ♀ and 4 ♂♂ from Brazil, Santa Catarina, São Bento do Sul, Rio Natal/Rio Vermelho, el. 450 m, 8. III. 1999, and 1 ♂ from "Santa Catarina state", demonstrating several color variations. **Fig. 2:** Eggs. **Fig. 3:** First instar larva. **Fig. 4:** Second instar larva. **Fig. 5:** Third instar larva. **Fig. 6:** Fourth instar larvae. **Fig. 7:** Cocoon, double-walled, with visible pupa inside. **Fig. 8:** Fifth instar larva. — **Fig. 9:** ♂ lectotype of Bouvier's *Copaxa canella flavobrunnea* (left middle) between ♂ and ♀ of *Copaxa canella* (left column) compared with ♀ and 2 ♂♂ of *Copaxa joinvillea* (right column) in BMNH, London.

lined with black scales, and antennae were pale. ♀♀ of all three species have pale antennae and are nocturnal.

Immature stages (Figs. 2–8) are typical for the *Copaxa flavina/lavendera*-group (Wolfe 1993). Fourth instar larvae of this group distinctly demonstrate single long hairs with knobbed terminal arising from the center of most scoli, similar to the widely familiar larva of *Saturnia pyri* ([Denis & Schiffermüller], 1775), but urticating spines are not present. Larvae fed readily on *Persea americana* (Lauraceae) and adults were full-sized. Adults eclosed from 1–4 months after pupation, with ♀♀ emerging at or soon after dawn and ♂♂ mostly within 2–3 hours after dawn, with several emerging in the afternoon, latest at 16:30 h.

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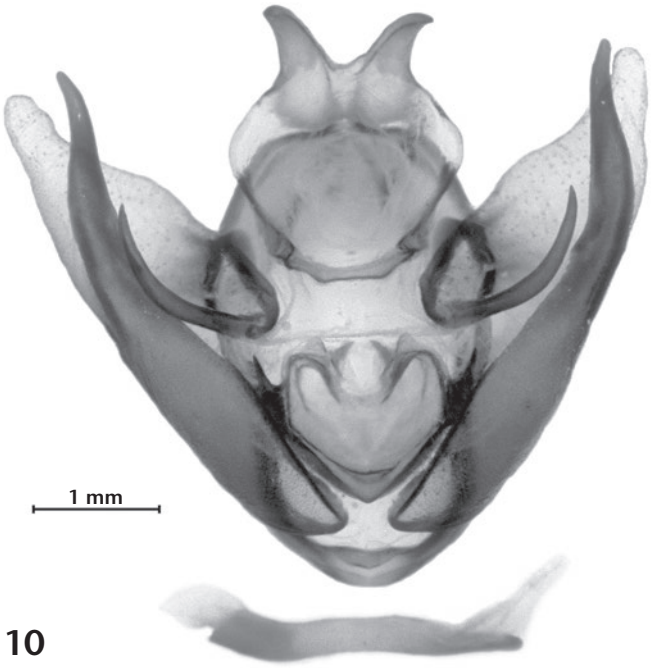

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Fig. 10: Male genitalia with removed aedeagus below. Damaged ♂ discarded, ♂ siblings illustrated in Fig. 1, from ♀ at light, Brazil, Santa Catarina, São Bento do Sul, Rio Natal/Rio Vermelho, el. 450 m, 8. III. 1999.

Discussion

Flight time of mating activity can represent a temporal barrier to gene flow. Discovery of this flight time through captive rearing and observation has been instrumental to us in identifying previously unsuspected species which have sometimes occurred with sympatric and synchronic similar species. ♀♀ of nocturnal-mating moths may be flying at night alongside similar ♀♀ of diurnal-mating moths and come to the lights together while the day-flying ♂ may never be encountered at the lights. Captive rearing is an important method of behavioral study for some moths.

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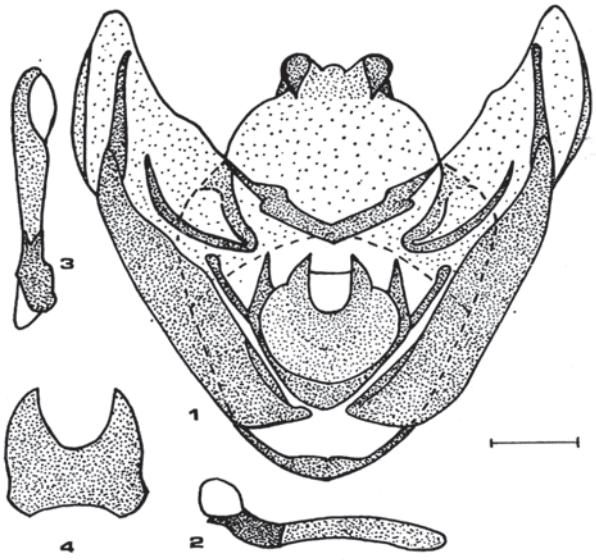

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Fig. 141. — Armure génitale ♂ de *C. canella*. 1, face ventrale, pénis détaché. — 2, pénis, vu latéralement. — 3, *id.*, face ventrale. — 4, uncus, face dorsale.

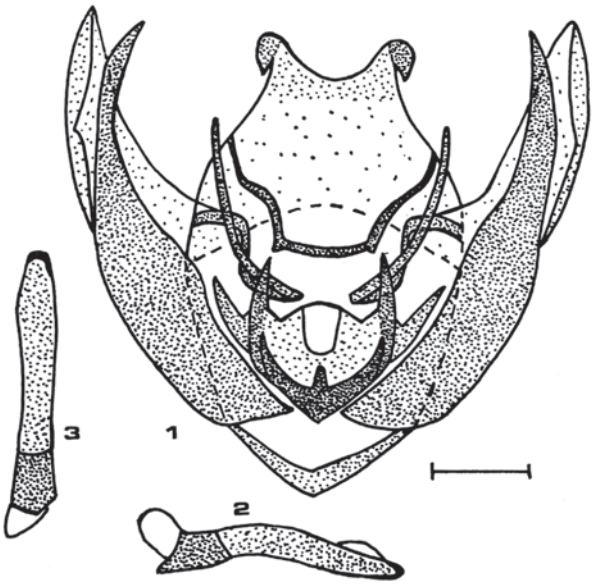

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Fig. 143. — Armure génitale ♂ de *C. joinvillea*. 1, face ventrale, pénis détaché. — 2, pénis, vu latéralement. — 3, *id.*, face ventrale.

Figs. 11–12: Drawings of the ♂ genitalia of *Copaxa canella* and *C. joinvillea,* from Lemaire (1978: figs. 141 [*canella*] and 143 [*joinvillea*]). – **Fig. 11:** *Copaxa canella*. **Fig. 12:** *C. joinvillea*. – Scale: 1 mm.

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